

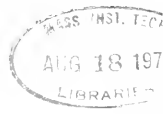




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TOWARD A THEORY ON HIGH-LEVEL MANPOWER PLANNING:
ALTERNATIVES AND SUGGESTIONS

Gail Cook Johnson

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G.C.J.
Cambridge, Massachusetts
June 1975

The importance of education within the overall planning of developing economies has received considerable attention within the last decade. As a consequence, numerous models for educational planning have been elaborated.¹ They have ranged from macro-dynamic programming models of the entire labor force to micro-simulation models of individual educational institutions. Regrettably, however, successful application of these models to real world situations has been limited. Their failure serves to underscore not only the various drawbacks of the modelling techniques as applied to the specific problems, but also the need for development of a valid theoretical basis on which to design further analytical modelling efforts. The purpose of this paper is to focus upon the theoretical problems involved in high-level manpower planning.

To this end, the paper will have three parts. In the first part, an overview of macro-planning models, or what Johnstone calls "comprehensively-externally-linked" models, will be presented. Given the objections to these models, I shall try, in a limited fashion, to improve upon them in Part II of this paper where a systems dynamics feedback structure is employed.² In my conclusions, substantive summary comments on the state of planning models in general and suggestions for future course of high-level manpower planning will be offered, using the framework presented in Part II.

PART I: AN OVERVIEW

Models used for macro-planning fall into three general categories. First, there are the economic demand models which have been most popular for planning in developing countries.³ They are best known under the heading

of "the manpower requirements approach". Models by Tinbergen, Correa and Bos are undoubtedly the most publicized. Secondly, there are supply models which project the private demand for non-compulsory education; Blaug (1967) refers to these models as social demand models.⁴ The British Robbins Report (1963) is the most notable example. Thirdly, there are the "integrated" models which include consideration for both the supply and demand of manpower. These models attempt to determine the value of various kinds of human capital and thereby project what investment there should be at the higher educational level for manpower over the planning period. Rate-of-return and linear programming models are included in this category.⁵

As these conventional models focus on different aspects involved in the planning of high-level manpower, the behavior of any one system posited by the different models is usually not consistent with any other.⁶ Such a dilemma has led Blaug (1967) to the conclusion that the three model categories are complementary rather than conflicting. More specifically, however, the fault lies in not taking account of the essential feedbacks which operate within the overall planning system.

For example, in conventional planning, future secondary school graduates are estimated over the planning period. These values, adjusted for withdrawals, rejections, and changes in entrance standards, are then introduced into the higher-educational planning model as the basis for future expansion. The social demand for education is, therefore, assumed to be independent of the future expansion and policies of institutions of higher

education on which the "integrated" models concentrate. Clearly, it would be more appropriate to allow the expansion of higher-educational facilities to have some impact on the social demand for higher education through (1) inducing greater expectations of continuation in higher education, (2) the provision of more highly qualified teachers graduating from high-level institutes to teach in the secondary schools and thereby improve the quality of applicants to higher education, and (3) changes in financial aid, diversity in course offerings, etc. In other words, the expansion of higher education facilities may feedback on the social demand for higher-education sub-model to further increase the social demand from what it would be if predetermined in conventional analysis.

In an analogous manner, if institutions of higher education graduate increasing numbers, employers may build into their plans increasing numbers of highly-educated manpower. Factors such as expected salaries will jointly be determined by and influence the number of graduates in each field and the employers' demand for high-level graduates. It is this mutual interdependence of each sub-sector which is a prime importance in manpower planning. The feedback relationships outlined above are shown in Figure 1. It should be compared to Figure 2 which presents how the sub-sectors are conventionally linked.

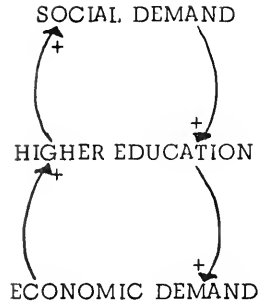


FIGURE 1: SUB-MODEL FEEDBACKS

As most models for macro-planning are also simple linear algebraic models, they all have been strongly criticized for their structural simplicity. But, as they are aggregate models, this simplicity is necessitated by both considerations for mathematical tractability and data limitations which are particularly severe in developing countries.

Clearly, non-linear relationships would obviate many of the ad hoc assumptions that are imposed upon linear models. Unfortunately, however, this "improved" representation is at the expense of the property of consistent aggregation:⁷ a mis-specification error may be introduced into the model which is of unknown magnitude and cannot be assessed with aggregate data. Thus, where planners do not have the a priori knowledge concerning the nature of the non-linear relationships, the linear relationship is usually desirable.

The above analysis suggests that we should begin to reorient our approach to planning and propose alternative means. To do this, we must

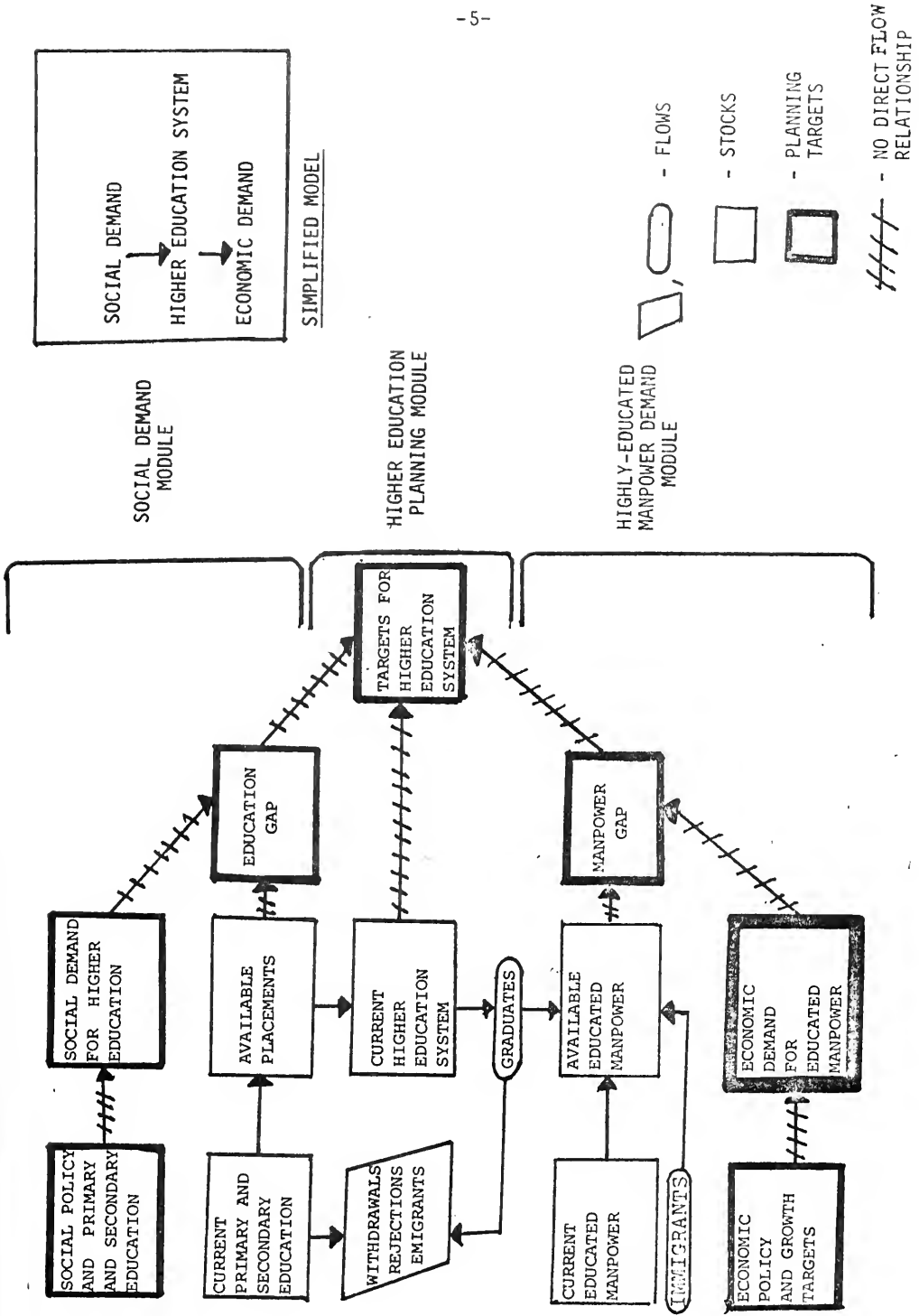


Figure 2: Representation of Interconnections Between the Three Model Categories as Perceived in Conventional Planning

examine the behavioral assumptions underlying our planning approach and realize the limitations; we must come to grasp with feedback behavior; and, we must begin to build up our macro-models from their micro-parts. A conceptualization of the important feedbacks (as exhibited in Figure 1) in a systems dynamics context offers us one alternative.

The process of conceptualization in systems dynamics terms can be enlightening:

- 1) by specifying feedbacks, we gain valuable insight into the interaction process;
- 2) by so doing, types of data and information which should be collected to facilitate future planning efforts are indicated; and,
- 3) by integrating systems of hypotheses, theories and postulates about behavior, we make an important step toward solving the substantial problem in the planning process.

In accord with the idea that one must begin building from micro-parts, the task set for Part II will concentrate on one specific area: the economic demand for educated manpower. Its relationship to the "whole" system is revealed in Figure 2. The pertinent "box" in this figure is represented by very heavy black lines. As a result, the social demand and higher-education sectors are not explicitly included. It will become clear, however, how they may enter as important policy variables, thereby taking into account their feedback relationships.

PART II: A MODEL CONCEPTUALIZATION WITH FEEDBACK BEHAVIOR

In order to attract attention to the fact that markets for highly-educated manpower are often highly institutionalized and that these factors may impinge upon the "market" influences of manpower demand and supply, I have couched the discussion in this section in terms of internal labor markets and labor market segmentation.⁸ Due to this disaggregation, certain restrictive assumptions must be introduced at stages of the analysis. They enter, particularly, when dealing with the external market which faces the internal market, and is defined as including other industry and services within the economy, locality, or prevalent labor market which will vary by occupational mobility, industry linkages, etc.

It is one intent of this paper to improve upon the assumptions of previous models, within a limited framework of the economic demand for educated manpower. ~~A~~Therefore, manpower requirements models are taken as the point of departure. The model alternative which is to be developed then deals primarily with market influences. In this regard, the demand for educated manpower is first discussed; then supply, both external and internal, and, finally substitution effects. It is in this final section that the complete demand equation is stipulated.

A. Internal Demand: The Manpower Requirements Approach

The manpower requirements approach which has dominated earlier modelling efforts may be best perceived as a natural extension to input-output

planning models.⁹ As such, sectoral output is related to occupational input as follows:

$$Q_i^t = Q(K_i^t, E_i^t)$$

where Q_i^t = output in industry i , at time t

K_i^t = capital stock in industry i , at time t

E_i^t = employment in industry i , at time t

Assuming no substitution between capital and labor, and no underemployment:

$$E_i^t = \alpha_i Q_i^t \quad (1)$$

$$E_{ij}^t = l_{ij} \alpha_i Q_i^t \quad (2)^{10}$$

where α_i = proportion of labor in industry i ,

l_{ij} = proportion of labor type j , in industry i .

α_i and l_{ij} are technologically determined and are obtained from expected time trends of labor productivity ratios or desired ratios.¹¹ In either case, employment is obtained from simple extrapolations of past behavior.¹²

Sensitivity analysis for this model relates differing values of E^t to differing values of α_i , l_{ij} , and Q .¹³ For educated manpower, this approach has not proven satisfactory. First, the relationship between output and high-level manpower often cannot be measured. A research engineer, for example, whether employed by industry or government, generally will not produce concrete output until the completion of a project which may take four or more years.

Further, this delayed output is highly dependent upon the quality of education.¹⁴

Secondly, α_i and ℓ_{ij} are not determined solely by technological factors. Apart from technology, α_i and ℓ_{ij} may in part depend upon employer hiring and promotion practices, and government policies to upgrade services (such as medical services). Where technology and capital do become important factors, the relationship between technology, capital, and labor is not clear. Recent evidence, in developed and developing countries alike,¹⁵ suggests that technology and high-level manpower are complementary. But, unfortunately, the current aggregate production functions underlying these econometric models provide an inadequate basis for identifying the role of heterogeneous educated manpower in production.¹⁶ Increased technology, for example, may reduce the demand for managers as lesser-skilled persons are displaced; but, it may increase the demand for technical personnel as the level of complexity is increased.¹⁷

Thirdly, the manpower requirements approach ignores supply. For this reason, it is often labelled a "doomsday" approach to planning: if requirements, as specified by the model, are not met, then it is impossible to meet the desired output target.

Freeman (1974) presents us with a useful generalization of the manpower requirements approach. He compares the technological assumptions of this approach to standard economic assumptions.

More specifically, Freeman essentially outlines general demand and supply relations which yield form equations for employment and wage change.

We define:

$$E_j^t = \sum_i \alpha_{ji} N_i = \sum_i \alpha_{ij} (N_i / Q_i) Q_i$$

Where occupational employment j is summed from occupational requirements as proportions of total labor requirements N_i / Q_i .

In logarithmic change form we have:

$$\dot{E}_j = \sum_i \alpha_{ij} \dot{N}_i = \sum_i \alpha_{ij} (\dot{N}_i / Q_i) + \alpha_{ij} (\dot{Q}_i)$$

Demand and supply are:

$$\dot{E}_{Dj} = \dot{E}_j - \zeta_j \dot{W}_j$$

$$\dot{E}_{Sj} = \dot{S}_j + \eta_j \dot{W}_j$$

where \dot{E}_{Dj} = the change in the number employed demanded

ζ_j = the average elasticity of demand in occupation j

\dot{W}_j = wage change

\dot{E}_{Sj} = log change in occupational supply

\dot{S}_j = exogenous changes in supply

η_j = elasticity of supply

We may then obtain equations for employment and wage change as follows:

$$\dot{E}_j = \eta_j (\alpha_{ji} \dot{N}_i - \zeta_j \dot{S}_j) / (\zeta_j + \eta_j) \quad (3)$$

$$\dot{W}_j = (\sum_i L_{ji} \dot{N}_i - \dot{Z}_j) / (f_j + k_j) \quad (4)$$

Equations (3) and (4) show that the fixed coefficient models will forecast employment perfectly for any shift in demand for labor when either the elasticity of demand is 0, or the elasticity of supply is infinite. As neither of these assumptions may be categorically accepted in the case of high-level manpower,¹⁸ Freeman's model indicates that a more heuristic modelling approach is desirable.¹⁹ This is done by first considering the external supply of the educated labor force.

B. Available Educated Manpower and the External Supply of Manpower

Each internal market will draw its employment from the external supply of educated manpower.²⁰ The available manpower will consist of the previous stock of educated manpower plus entrants, less attrition. The flow supply of entrants will be derived from graduates of higher educational institutions, occupation changers, and immigrants (which also include nationals returning home). Attrition will include emigrants, deaths, retirees, and occupation changers who are leaving the particular supply pool.

These flows into the labor market will respond differently to both wages and non-wage signals in the external labor markets.²¹ In addition, the transition barriers for occupation changers will differ according to previous experience and type of educational training.²² For this reason, gross flow models which distinguish among sources of labor supply are analytically useful.

A simple model relating both entrants and exits to relative salaries may be illustrated à la Holt as follows:

$$\begin{aligned} \dot{E}_{Sj} = & g\left(\frac{W}{W}\right) G_j + o\left(\frac{W}{W}\right) O_j + m\left(\frac{W}{W}\right) M_j - \\ & n\left(\frac{W}{W}\right) N_j - l\left(\frac{W}{W}\right) L_j - R_j - D_j \end{aligned} \quad (5)$$

where G_j = graduates of higher educational institutions

O_j = occupation changers (entrants)

M_j = immigrants

N_j = occupation changers (exits)

L_j = emigrants

R_j = retirees

D_j = deaths

Graduates and occupation changers are influenced by the average salary for a particular occupation relative to the average salaries for all others. Immigrants and emigrants, whom I assume have already chosen their occupations, are influenced by geographical differences in salaries. Retirees and deaths are not generally sensitive to incentives.

The non-economic incentives relating to occupational preference are more difficult or impossible to classify as they include many personal factors which may vary with each individual. For example, the mobility decision, apart from the salary issue, can be based upon considerations for research and career opportunities, family influence, moral perspectives, and cultural/

political climate.²³ The decision of graduates and occupation changers to pursue one occupation versus another, given that there are cross-flow possibilities, will be based not only upon highly personal preferences such as perceived career opportunities, family influence and general inclinations, but also upon the status given to a particular occupation within the social milieu of a country. As the latter factor may be considered a more general indicator of private preference for an occupation,²⁴ we may include it in equation (5) as an exogenous variable influenced by social policy:

$$E_{Sj} = g\left(\frac{w}{w}, \frac{OS_1}{OS_2}\right)G_j + o\left(\frac{w}{w}, \frac{OS_1}{OS_2}\right)O_j \dots - \quad (5a)$$

$$n\left(\frac{w}{w}, \frac{OS_1}{OS_2}\right)N_j \dots\dots$$

where $\frac{OS_1}{OS_2}$ = occupational status in one occupation relative to another. (I assume that there are only two occupations demanding high-level manpower in the economy.)

As the private and educational sectors are not included in the model, we have not dealt with decisions made by persons prior to graduation. They are, however, important to mention. Apart from salary considerations, the decision for a national to pursue a career within the economy will be influenced by family socialization and intellectual ability. Those willing and able to pursue a degree course, or better, will then consider expected salary levels, the places available in the higher educational institutions for that course of study, and the financial costs of education.²⁵

To determine the supply of manpower, and therefore the gross flows in the external market, one would need to obtain estimates of relative salary functions as well as the occupational status functions. If we introduce a relation which determines salaries endogenously (in most labor demand models they are usually assumed to be exogenous), the dynamic feedbacks become clear. The systems dynamics differential salary function becomes:

$$\dot{W}_j = w(E_{Dj} - E_{Sj}) \quad (6)$$

Salaries are determined by the demand and the supply of available manpower in the external market. The salary levels represent average hiring salaries. This is a necessary simplification; all new hires will not be hired at the same level.

C. Employment Determination in the Internal Market

Employment within the internal labor market is determined by both individual supply decisions and employer hiring decisions such that:

$$E_{ij} = \text{Hires} - \text{Separations} \quad (7)$$

where Hires = graduates, immigrants and occupation changers hired into the internal manpower market ,

Separations = involuntary quits and voluntary job changers

These employment decisions involve consideration for both economic and non-economic factors. However, for the initial analysis, the labor market flows

will be assumed to be determined by the internal industry salary versus the external salary for that occupation so that individual supply decisions will depend upon these relative salary levels.

This incentive relationship should be qualified; a job changer will not consider the salary levels in absolute terms. Their importance as a decisive factor will be weighed according to what the individual perceives promotional opportunities to be within the internal market (and therefore the expected salary there), to what the individual perceives career opportunities and salary levels to be outside.²⁶ If an employee, for instance, expects promotional opportunities to be similar or better in the external market, and that market is offering a higher relative salary, the individual will leave.²⁷ Important, in this regard, is the fact that it is what the individual perceives, rather than what actually may be. Thus, by this analysis, one would expect greater mobility to be experienced by the very young and the unsuccessful who are also disgruntled by their lot.²⁸ Older workers, in general, will perceive their promotional chances, if any, to be greater where they are.²⁹ The specification of employment equation (7) will therefore become:

$$E_{ij} = H\left(\frac{w_I}{w_{II}}\right)S_j - P\left(\frac{w_I}{w_{II}}\right)E_{ij} \quad (7a)$$

where H = the hires function for relative salaries

P = the separations function for relative salaries

Employers in the internal market will adjust their salaries to the external salaries according to their level of excess demand for educated manpower or unfilled vacancies. The rate of wage or salary change in the internal market will be:

$$\dot{W}_{ij} = W(V_{ij}) \quad (8)$$

$$V_{ij} = E_{Dij} - E_{ij} \quad (9)$$

$$\dot{V}_{ij} = \text{Separations} + \text{Increased Demand} - \text{Hires} \quad (9a)$$

where V_{ij} = unfilled vacancies

The salary rate as it relates to the supply, demand and employment will not, however, adjust instantaneously. An increase in demand relative to supply will necessitate an increase in the salary if employers wish to attract more people into employment. The speed of adjustment for the salary will depend upon how quickly employees and perspective candidates gain information on market conditions.³⁰ Perspective employees, if they perceive that they can get a higher salary by "holding out longer", and salaries are increasing more quickly elsewhere, will not offer their services to the internal market. Similarly, if employees perceive salaries to be rising faster outside of the internal market and feel unfairly treated, they will leave the internal market to look elsewhere.

In the market for high-level manpower, this adjustment process may be very slow. First, highly-educated manpower form a very heterogeneous

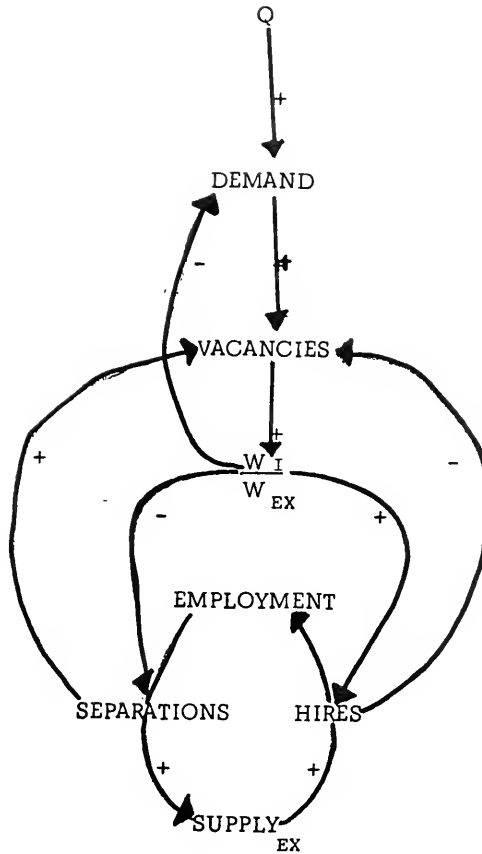


Figure 3: Internal Labor Market Employment
Model

group and even if a professional should know of higher salaries elsewhere, it is likely to be assumed that this difference is due to differing responsibilities and qualifications. Second, as high-level manpower progresses in their careers, they become tied to the internal manpower market so that higher starting salaries within the market have a lesser motivating impact on older workers. Thus, a market's adjustment process will be primarily concerned with the actions of the younger workers. Lastly, where high-level manpower work under contract, the salary adjustments even for the younger persons may be seen to operate in a step-like function.

In a systems dynamics model, the lagged response in salary adjustment by the employers and the adaptive salary expectations of employees may be introduced by using appropriate delays in the feedback responses. The feedback loop diagram for equations (7) to (9a) is depicted in Figure 3. The external salary is introduced exogenously.

The non-economic incentives are impossible to capture within the scope of our model. But, it is important to isolate them. From the supply side, chief among these non-economic incentives is ^{the} organizational climate of an enterprise which relates not only to physical working conditions but to the flexibility of the organizational system.³¹ Gerstl, for example, in his study of engineers in Great Britain, found that small firms lost many of their graduate engineers through voluntary quits because the technical promotion ladders found in small firms were too short and encompassed many meaningless and frustrating tasks for graduates.

The relative stability of employment may also be considered pertinent for high-level manpower, particularly, because lateral mobility may be restricted increasingly as careers advance. Gerstl, in the same study, for instance, noticed that older engineers who changed jobs tended to go from the industrial sector to the non-industrial sector such as the civil service rather than vice versa. The latter generally offers more stability and possibly higher benefits apart from salaries.

From the demand side, characterization in solely economic terms is also a simplification. Employers can be expected to engage in job search of various sorts such as visits to institutes of higher education, ads in professional journals, and personal contacts, since the salary offer is usually insufficient in itself to attract candidates. Employers also engage in non-salary methods for reducing separations: professional status accorded to an employee, hierarchies within the firm, pension benefits and previous firing practices will influence the voluntary tenure of employees.

D. Substitution in the Internal Market

The preceding section has assumed that there is no substitution. Clearly, however, one kind of labor may be substituted for another. The manpower requirements approach, as noted by Freeman, assumes that the elasticity of substitution is equal to 0, such that:

$$E' = \min \left[\frac{E_1}{a_1}, \frac{E_2}{a_2} \right]$$

$$a_1, a_2 = E_1/Q, E_2/Q$$

where a_1, a_2 = the minimum amount of labor type 1 and 2 required to produce Q .

Educational levels for each occupation are measured as a function of output per worker. This is done in two ways: by the one-stage approach which relates educational levels in each sector to output per worker; and, the two-stage approach used in the Mediterranean Regional Project which translates occupations in each sector to output per worker, and then relates educational levels of each occupation to output per worker. The disagreement between the two approaches, which is often discussed, actually hinges on nothing more than when the relation between occupation and education should be computed.³²

Either method, however, makes the manpower requirements approach untenable. Hollister, for example, found that there would be as much as a 20% difference in estimates of manpower requirements in the United States if substitution were accounted for. Further, econometric evidence suggests that the elasticities of substitution are quite high.³³

But, like the capital-labor substitution studies, these econometric studies are limited in their usefulness. Few studies have attempted to analyze the problem on a one-market basis.³⁴ The remainder have resorted to international comparisons where the data are more plentiful, but (1) educational and occupational categories are too broad to be meaningful, and (2) major differences between occupational-educational levels in each country indicate no

one-to-one correlation for complete comparison purposes.³⁵

The intent of this section is, therefore, directed toward classifying the dynamics of substitution. In terms of the model so far defined there are two kinds of substitution which may take place: 1) substitutions between different occupations,³⁶ and 2) substitutions between high-level manpower and manpower with lesser education within an occupation.

The decision to substitute one kind of labor for another, or one occupation for another, will depend upon the relative salaries or wages (assuming a 40-hour week for hourly-paid employees) for the types of labor or occupations in question. The derivation of these salaries, as indicated by the model outline in the last section, are indicators of shortages of supply.

More fully, standard analysis suggests that demand for a factor will depend upon the factor cost and the level of output. This may be represented as:

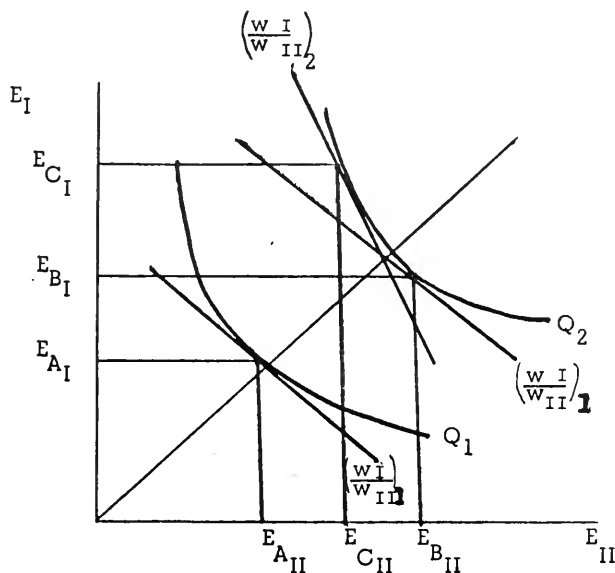
$$E_{Dij} = E\left(\frac{w_I}{w_{II}}, Q\right) \quad (10)$$

where $\frac{w_I}{w_{II}}$ = relative salary levels for high-level manpower in two occupations or relative salary-wage levels for high-level manpower to less-educated manpower.

If we assume that the salary impact in substitution is independent of the scale of production,³⁷ we have:

$$\dot{E}_{Dij} = \alpha (Q_2 - Q_1) + p \left[\left(\frac{w_I}{w_{II}} \right)_2 - \left(\frac{w_I}{w_{II}} \right)_1 \right] \quad (11)$$

The change in demand for high-level manpower in an occupation is a function of a change in output plus a change in relative salaries. These two shifts are presented diagrammatically in Figure 4.



E_{AII} = starting point

$$E_{BII} - E_{AII} = \propto (Q_2 - Q_1)$$

$$E_{BII} - E_{CII} = p \left[\left(\frac{w_I}{w_{II}} \right)_2 - \left(\frac{w_I}{w_{II}} \right)_1 \right]$$

Figure 4: Shifts in the Change of Demand

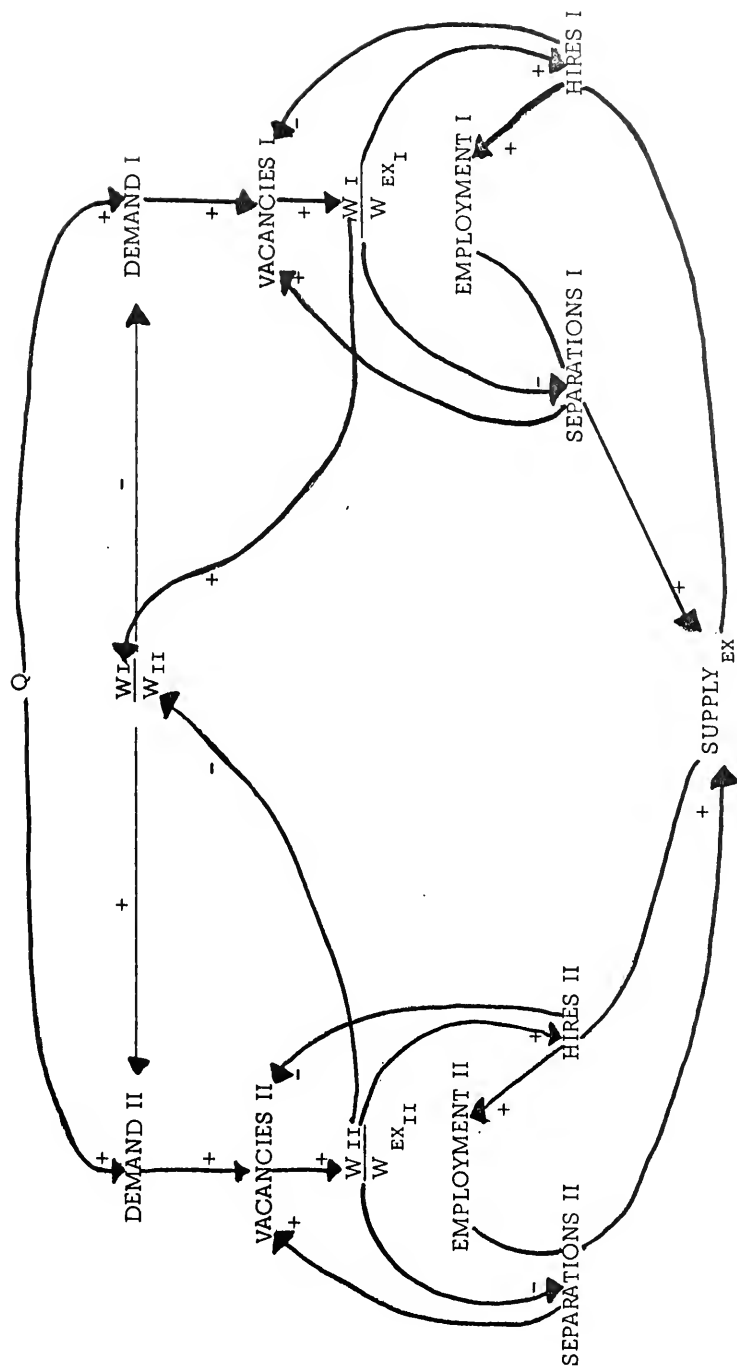


Figure 5: Internal Market Employment Model With Occupational Substitution

Figure 5 shows the systems dynamics feedback structure for occupational substitution. The feedback structure for educational substitution would be similar with a few exceptions: 1) there would be two external supply pools: one for highly-educated manpower, and 2) wage determination loops (pictured on the left side and the right) would represent two different types of labor within the same occupation, rather than similarly educated manpower within two different occupations in the internal manpower market as does Figure 5.

Once again, however, the analysis of substitution represents a simplification. First, wages and salaries will not be the only costs associated with substitution. Training and its associated costs will be a major consideration. Secondly, the manpower supplies are not homogeneous. Individuals will vary not only in their educational qualifications and occupational positions, but in their amount of experience, innate ability and quality of education. It is unfortunate that we know so little about the relationship between education, training experience and other criteria which can serve as determinants for successful performance and substitution for various kinds of manpower.³⁸ For this reason, they cannot be realistically modelled.

PART III: CONCLUSIONS - QUESTIONS TO BE ANSWERED

The model conceptualization outlined in the preceding section is an improvement over previous model conceptualizations in that it did specify feedbacks and attempted, through disaggregation, to gain insights into the factors which segment labor markets occupationally, and determine employer and employee responses at the micro-level. Sensitivity analysis of this model would show the dynamic behavior of supply and demand to salary and wage signals within the internal market.

As noted throughout the discussion, however, many important institutional variables have been excluded, and many assumptions have been made. These factors point to limitations of systems dynamics:

- 1) In order to be conceptually clear, and therefore useful, any problem proposed to systems dynamics must be narrowly defined;
- 2) While the model is a good counterpoint to other planning models in that assumptions are clearly stated and open for review, a distinction should be made between assumptions which exist in the theoretical realm and real world behavior. Theory, by definition is an abstraction from the real world; it will imitate actual behavior only in so far as the assumptions may be valid to the actual case. But, clearly, it may be the case that there are restrictions to immigration and emigration (which the model has not considered) and that there are not clearly defined internal labor markets, and,
- 3) If the model were to be run, data would pose limitations.

However, the latter two problems exist because we do not possess specific knowledge on either the behavior of a micro-system or have data which apply at this level. The first problem, it may be argued, is common to all modelling techniques. For this reason, as we have argued that planning must begin at the sectoral level, any planning model at this point of time will exist in the realm of the plausible hypothetical rather than necessarily in the real world.

Thus, the assumptions and the omissions in the model, more generally, raise an important methodological dilemma which plagues the manpower planning area. Educational planning has led a rather schizophrenic existence: on the one hand, we have macro-models from which inferences about micro-behavior have been construed (or misconstrued!); on the other hand, we have isolated micro-studies which, with few exceptions³⁹, have not been clearly oriented toward improved aggregate educational planning. The challenge, then, in educational planning, at present, is to deal more meaningfully with labor market behavior at a micro-level (develop sectoral planning models) and then to aggregate this information to develop overall educational targets.

It is, therefore, the view of this paper that micro-studies should always be directed at providing information required for aggregate planning. In this regard, the framework presented in Part II presents us with a useful structure in which to pose important questions for future research.

Flows from the External Market

The isolated gross flows present us with certain problems. With respect to graduates, the objective of manpower policies should be to stabilize the flow of this supply of labor such that the country will have its own independent source of high-level manpower. The chief question to be asked here is, "How does policy stabilize this flow of graduates while taking into account the capacities of the universities over the planning period, the social demand for education, and the economic needs of the economy?" Under this general question, many "micro" questions may be posed. How are the university facilities best planned and distributed throughout a particular economy? Would the provision of more information on job opportunities previous to career choice improve the fit between demand and supply? If so, how could this be done? What effect do the "specialized" educational systems common to European and developing countries have on the flow of needed graduates as there is an inevitably long lag time between career choice and completion of degree qualifications?⁴⁰ Given that the cost of education is an important factor affecting the demand for education, what costs of education are considered pertinent to the perspective student and his family?⁴¹ (Knowing this information would aid in deciding what kinds of educational subsidies are necessary). Lastly, as the quality of education, as mentioned, is important, how is the quality of education best improved. Much is written on the quality of education, but, few substantive solutions are offered for any one country.

In the short-run, immigrants can serve as an important source of high-level manpower to a developing country. They can be used to teach new

graduates, train manpower in other ways, and act as a bridge to the developed world. However, what is the quality of immigrant manpower that a country usually receives? Developing countries are often cut off from forums such as research conferences and high-quality institutes of higher education which can be useful in attracting high-level manpower from other countries. What effect would the creation of wider recruiting areas have on attracting manpower of good quality? What "inducements" are most persuasive?

Despite the fact that much has been written on the "brain drain," no country has good data on the flow of emigrants. Should not this information be tabulated so that a country will know (1) the magnitude of their loss, and (2) pertinent characteristics (occupations, qualifications and reasons) of people who are leaving the country? Such information could have important implications for manpower planning.

The Internal Market

The questions posed in the previous section aim at obtaining micro-data which will be useful to the internal manpower markets or sectors of the economy. But, much of the basic data must be gathered at the sector level. Here, many questions may be answered.

A major problem facing manpower planning is that there are no adequate and comprehensive definitions of an occupation. What defines an occupation? How encompassing can a definition be so that it may be standardized over sectors, and how specific must it be for planning purposes? Once adequate definitions are established, is adoption by the government enough to encourage industries to implement these standards? By looking

carefully at the responsibilities and characteristics of job structures within firms, industries and between industries the first two questions may be answered.

If one expects that there is some scope for inter-occupational substitution and for substitution between manpower of all kinds and other factors of production, if realistic production goals are to be met in the face of shortages, the concept of labor force requirements becomes a good deal more complicated than other models realize. Our model, for example, shows the case for only two occupational sectors and two kinds of educated manpower, this number may extend greatly. Thus, within occupations, what is the relationship between performance and experience, performance and education, performance and training of other kinds, such as on-the-job training and vestibule school. If obsolescence in certain careers is an important factor, what kind of up-date courses are recommended? If the traditional career path for particular personnel is, for example, from a technical job to a managerial post, what new training procedures are recommended? When traditional career paths are ordered in this way, does the career path concept become an important consideration for the definition of occupations? Clearly, education, training, experience, obsolescence, and career paths all have important repercussions for educational planning.

Secondly, what is the relationship between one occupation and another? In this regard, what causes employers to substitute this particular occupation for that, and what causes persons to voluntarily change their occupation?

Is there any way to match those flows?

Thirdly, more concrete micro-research needs to be done on the relationship between capital, technology and various kinds of occupational and educational requirements, if future employment demand studies are to meet specialized goals of educational planning.

Lastly, what institutional rigidities may exist within sectors which prevent the enactment of plausible substitution arrangements within the labor markets? These institutional rigidities may exist either due to ignorance of alternative strategies and/or from adverse pressure from interest groups within the system.⁴² In this regard, organizational climate is an important consideration.

The Relationship Between Sectors

As shown by the model, the internal market does not operate totally independently of the other sectors which may not only compete for sources of labor, but may also create policies which will ultimately feedback to the internal labor market in many ways. In developing countries, for example, planning of government manpower needs and government policy toward manpower can particularly exacerbate disequilibrium in the private labor market through the setting of salaries in an artificial manner, and through the spontaneous build-ups and cut-backs in output in government-related projects. This interdependence not only has implications for how sectors shall be aggregated to complete national educational targets, but also poses problems to be studied when comparing sectoral studies. In short, how might planning

sectors be better co-ordinated?

Finally, the effect of national policies, specifically, must be related to the internal markets. For example, what effect does artificially low interest rates have on the stability of the internal labor market and the commitment of the labor force to that market?

The above questions are by no means intended to be exhaustive. They do, however, indicate new lines of research which, in fact, are unavoidable if a nation is to develop a comprehensive overall planning package.

NOTES

1. A general survey of educational models can be found in OECD, Mathematical Models for the Education Sector: A Survey, (Paris, 1973).
2. In Systems Dynamics Flow Diagrams, positive flows (+) indicate that the greater the origin of the flow, the greater the end product of the flow; negative flows indicate that the greater the origin of the flow, the lesser the end product of the flow. Similarly, feedback loops which are "circular" combinations of the flows may be positive or negative. For example, two positive flows may make up a positive feedback loop; a positive and negative flow may make up a negative feedback loop. A negative feedback loop is indicative of a system which contains its own control system; a positive feedback loop is indicative of a system which may be highly "explosive." More detailed information on Systems Dynamics is contained in J. Forrester, Principles of Systems, (Cambridge: Wright-Allen Press, 1971).
3. For a comprehensive list of manpower requirements models as they have been developed and applied in particular countries, see J. N. Johnstone, "Mathematical Models Developed for Use in Educational Planning," Review of Educational Research, vol. 44, No. 2, (1970).
4. The difference between projections and forecasts is often distinguished in the literature. For example, "a 'forecast' will always mean a prediction subject to the achievement of a certain economic growth target, that is, a statement of what would happen if economic growth were deliberately manipulated 'Projections', on the other hand, predict the outcome of purely spontaneous forces, that is, what will happen in the normal course of events in an unplanned economy." See M. Blaug, "Approaches to Educational Planning," Economic Journal, vol. 77, No. 2 (1967), p. 264-265.
5. Though there are many such models, Theodore Schultz is well known for rate-of-return models. Samuel Bowles is well known for linear programming models. For the most recent developments in linear programming models, see Irma Adelman, "A Linear Programming Model of Educational Planning: A Case Study of Argentina," in Adelman and Thorbecke, eds., The Theory and Design of Economic Development, (Baltimore: Johns Hopkins, Press, 1966). For favorable comments on linear programming models, see J. F. McNamara, "Mathematical Programming Models in Educational Planning," Review of Educational Research, vol. 41, No. 5 (1970).

6. Samuel Bowles, Planning Educational Systems for Economic Growth, (Cambridge: Harvard University Press, 1969), for example, compares results obtained from manpower requirements models, a rate-of-return model, and a linear programming model as they were applied to Greece and found that they recommended widely varying results.
7. G. H. Orcutt et al., Microanalysis of Sociometric Systems: A Simulation Study, (New York: Harpers and Brothers, (1961), give a simplified discussion on the distinction between linear and non-linear modelling approaches, p. 11-12.
8. The internal labor market concept is akin to that developed by Peter Doeringer and Michael Piore, Internal Labor Markets and Manpower Analysis, (Lexington: D.C. Heath & Company , 1971). In this paper, however, it is meant to apply specifically to high-level manpower and not the less-skilled as Doeringer and Piore have done.
9. For a careful discussion of the manpower requirements approach, see B. Ahamed and M. Blaug, The Practice of Manpower Forecasting, (Washington: Jossey-Bass Inc., 1973). For comments on the basic approach see essays in M. Blaug, ed., Economics of Education, vol. 2, (London: Penguin Books, 1968).
10. For a complete explanation of these equations see C.R.S. Dougherty, "Substitution and Structure of the Labour Force", Economic Journal, vol. 82, No. 325, (1972), p. 171-172.
11. The desired ratio approach was first developed by Herbert Parnes, "Relation of Occupation to Educational Qualifications", in Parnes, ed., Planning Education for Economic and Social Development, (Paris: OECD, 1962), p. 147-158. Labor productivity ratios are used by P.R.G. Lyard and J. C. Saigal, "Educational and Occupational Characteristics of Manpower: An International Comparison", British Journal of Industrial Relations, vol. 4, No. 2, (1966).
12. An error frequently made in manpower requirements is to use past coefficients as a basis for extrapolating behaviors. Where the coefficients are below desired levels in the past (as often is the case), use of these coefficients forecasts the planner into further shortages.
13. See B. Ahamed and K. Scott, "Sensitivity Analysis in Manpower Forecasting," J. R. Statistic Soc. A., vol. 135, Part 3 (1972).

14. For good discussions on the quality of education and how it is an important concern for developing countries and planning of manpower targets, see C. Beeby, The Quality of Education in Developing Countries, (Cambridge: Harvard University Press, 1966), and J. Vaizy, "The Role of Education in Economic Development," in H. Parnes, ed. (1962).
15. For example, see Z. Griliches, "Capital-Skill Complementarity," Review of Economics and Statistics, vol. 51, No. 4 (1969), and, G. Psacharopoulos, and K. Hinchcliffe, "Further Evidence on the Elasticity of Substitution Between Different Types of Educated Labour," Journal of Political Economy, vol. 80, No. 4, (1972).
16. One drawback to Systems Dynamics also seems to be that they have not been able to adequately characterize production functions. For this reason, the symbolic relationship between Q and Demand, is kept throughout the discussion. However, the limitations have been mentioned.
17. I. A. Lyasnikov, "Training of Specialists of Soviet Industry", in V. E. Komarov, ed., "Selections Concerning the Training of Qualified Specialists," in Readings in the Economics of Education, (Paris: UNESCO, 1968), does some basic research in this area as it applies to the Soviet Union.
18. This view is also supported by R. B. Freeman in an article entitled, "Supply and Salary Adjustments to the Changing Science Manpower Market: Physics, 1948-1973," The American Economic Review, vol. 65, No. 1, (1975). The article deals specifically with high-level manpower.
19. It should be made clear how different the model to be developed is from that developed by Freeman. Freeman's model, for example, moves from equilibrium point to equilibrium point. The model to be outlined is therefore more "heuristic" because it traces behavior over time and is not an equilibrium model.
20. Each internal labor market will have a limited external supply of manpower to draw upon. This supply will be determined by the employment in related industries (i.e., firms can bid labor away from other firms), geographical mobility in an occupation, local institutions training persons for that occupation and so on.

21. On the importance of economic and non-economic incentives, in general, see S. C. Kelley, "The Role of Incentives in Human Resource Planning," in H. Parnes, ed., (1962), and F. Harbison and C. A. Myers, Education, Manpower and Economic Growth, (New York: McGraw-Hill, 1964).
22. As an example of transition barriers, we may suppose that practicing medical doctors may become research scientists, while engineers, without more complete re-education, would have difficulty becoming doctors.
23. For specific research in this area, see J. R. Niland, The Asian Engineering Brain Drain, (Lexington: Heath-Lexington Books, 1970).
24. J. E. Gerstl and S. P. Hutton, Engineers: The Anatomy of a Profession: A Study of Mechanical Engineers in Britain, (London, Tavistock, 1966), found, for example, that the low occupational status accorded to engineers in Britain was a great hindrance to inducing an adequate flow of graduate engineers.
25. On the problems that many developing countries experience in attempting to reorient themselves away from the traditional, elitist society and associated philosophies, see Adam Curle, Educational Strategy for Developing Societies, (London: Tavistock, 1963).
26. The theory of wage comparisons was developed by M. Patchen, The Choice of Wage Comparisons, (Englewood-Cliffs, New Jersey: Prentice-Hall, 1961).
27. A higher current salary is viewed by the employees as a proxy for higher wages in the future.
28. This is born out by J. E. Gerstl and S. P. Hutton, Engineers: The Anatomy of a Profession: A Study of Mechanical Engineers in Britain.
29. L. Bailyn and E. H. Schein, "A Taxonomy of Technically-Based Careers," Sloan School of Management Working Paper #728-74, (1974), and L. Bailyn, "Engineering Based Careers: A Study of the Relation to Work at Mid-Career," Sloan School of Management Working Paper #715-74, (1974), find, in their sample of MIT graduates, that the vast majority of technical personnel become managers eventually within their organizations. Secondly, L. Bailyn, "Accommodation as a Career Strategy: Implications for the Realm of Work," Sloan School of Management Working Paper #728-74, (1974), notes that technical people that do not experience upward mobility accommodate themselves

to their position in the organization and develop outside interests rather than leave. As R. Perucci and J. F. Gerstl, Profession Without a Community: Engineers in American Society, (New York: Random House, 1970), point out, obsolescence of skills in many technical positions can account for this immobility.

30. For an elaboration, see K. J. Arrow and W. M. Capron, "Dynamic Shortages and Price Rises: The Engineer-Scientist Case," Quarterly Journal of Economics, vol. 73, No. 2 (1959).
31. The importance of organizational climate and its importance to high-level manpower may be inferred from E. H. Shein's article entitled, "The Hawthorne Group Studies Revisited: A Defense of Theory Y," Sloan School of Management Working Paper #756-74, (1974).
32. This view contradicts, for example, the view of P. R. G. Layard and J. C. Saigal in "Educational and Occupational Characteristics of Manpower: An International Comparison," when they write, " (the two-stage approach) takes no account of the educational level of particular occupations within each economic sector," (p. 231).
33. See S. Bowles, Planning Educational Systems for Economic Growth, and C. R. S. Dougherty, "Substitution and Structure of the Labour Force."
34. For an exception, see M. L. Skolnick, "An Empirical Analysis of Substitution Between Engineers and Technicians in Canada," Relations Industrielles, vol. 25, No. 2, (1970).
35. For an indication of what these variances may be, see H. Parnes, "Relation of Occupation to Educational Qualifications."
36. For example, if there is a shortage of hospital administrators, doctors may be substituted to make up the difference.
37. The Cobb-Douglas or the CES production functions are always used. Both assume constant returns to scale.
38. A. Folger et al., Human Resources and Higher Education, (New York: Russell-Sage Foundation, 1970), outline the few studies which have been done in the United States. These studies indicate how difficult it is to pin-point the determinants of performance.

39. For an exception see the preliminary study by M. Blaug et al. entitled The Utilization of Educated Manpower in Industry: A Preliminary Report, (London: Oliver and Boyd, 1967).
40. M. Blaug, "Approaches to Educational Planning," mentions the problems which may be associated with this kind of education.
41. G. H. Orcutt et al., Microanalysis of Sociometric Systems: A Simulation Study, discuss plausible research suggestions in the area of social costs of education at the higher-education level (p.257-284) .
42. H. Leibenstein, "Shortages and Surpluses in Education in Underdeveloped Countries: A Theoretical Foray," in C. Anderson and M. J. Bowman, eds., Education and Economic Development, (Chicago: Aldine, 1965), offers a plausible analysis of what I call "institutional rigidities."

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